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SPECIFICATION

TITLE

"ANTENNA ARRAY FOR A RADIO STATION WHICH CAN BE OPERATED IN A PLURALITY OF FREQUENCY RANGES, AND A RADIO STATION"

BACKGROUND OF THE INVENTION

The invention relates to an antenna array for a radio station which can be operated in a plurality of frequency ranges, and a radio station, in particular a multiband mobile station.

National regulatory authorities divide a frequency range (around 900 MHz) provided for a radio system or mobile radio system, for example the GSM 900 (Global System for Mobile Communication) system, into different frequency bands, which are then allocated to different network operators, for example D1, D2. A different frequency range (around 1800 MHz) is allocated to a different mobile radio system, the DCS 1800 (Digital Communication System). Further different frequency ranges are allocated to further, if necessary, future mobile radio systems, such as the UMTS (Universal Mobile Telephony System) which is currently being standardized. In the case of a duplex system involving FDD (Frequency Division Duplex) systems such as the GSM system, different frequency bands can be provided for the uplink (mobile station to base station) than for the downlink (base station to mobile station). The duplex spacing is 45 MHz for the GSM 900 system and 95 MHz for the DCS 1800 system.

Terms and examples used in this application also often relate to a GSM mobile radio system. However, they are in no way restricted thereto; but with reference to the description, can also be easily

mapped by a person skilled in the art onto other, if necessary, future mobile radio systems such as CDMA systems, in particular wideband CDMA systems or TD/CDMA systems.

Mobile stations are known which, under the name of dual-band mobile stations or multiband radio stations, can be operated in a plurality of these frequency ranges and enable alternative communication via a plurality of these aforementioned mobile radio systems.

Figure 8 shows a schematic representation of a transceiver system of conventional mobile stations of this type. According to the different frequency ranges of the GSM system and the DCS system in which the mobile station can be operated, different power amplifiers GSM PA, DCS PA are provided whose transmission signals are fed via an antenna switch S and a diplexer D, which essentially comprises a filter or duplexer, and an antenna ANT, such as a rod antenna. In the opposite direction, reception signals are received by the antenna ANT and are fed via the diplexer D and the antenna switch S to the reception amplifiers (low noise amplifiers) GSM LNA, DCS LNA corresponding to the different frequency ranges of the different mobile radio systems. An antenna switch S and a diplexer D (or a duplexer) are contained in the antenna array or are assigned to the antenna.

However, there has recently been an increasing requirement in radio stations, particularly in mobile stations for increasingly smaller, more compact and lighter devices.

SUMMARY OF THE INVENTION

An object of the invention is to indicate an antenna array for a radio station which can be operated in a plurality of frequency ranges and which enables implementation of small, lightweight radio stations, in particular mobile stations.

A mobile station for operation within different mobile radio systems to which a different frequency range is in each case allocated. Each frequency range in each case has a transmission frequency band and a reception frequency band. A first transmission antenna is provided for transmitting signals within the transmission frequency band of the first frequency range. A second transmission antenna is provided for transmitting signals within the transmission frequency band of the second frequency range. The first reception antenna is provided for receiving signals within the reception frequency band of the first frequency range. A second reception antenna is provided for receiving signals within the reception frequency band of the second frequency range.

In a method of the invention, a mobile station is operated within different mobile radio systems to which a different frequency range is in each case allocated. Each frequency range in each case has a transmission frequency band and a reception frequency band. Signals are transmitted within the transmission frequency band of a first frequency range with a first transmission antenna. Signals are transmitted within the transmission frequency band of a second frequency range with a second transmission antenna. Signals are received within a reception frequency band of the first frequency range with a first reception antenna.

Signals are received within a reception frequency band of the second frequency range with a second reception antenna.

The invention is therefore based, among other concepts, on the idea of using a plurality of antennas, whereby different antennas are provided for transmission signals and reception signals.

As a result, antenna switches are no longer required and therefore a small, lightweight antenna array is implemented for a radio station which is operated in a plurality of frequency ranges.

In a further design, different antennas are also provided for different frequency ranges.

As a result, a diplexer or duplexer can also be dispensed with and an even smaller, more lightweight antenna array can therefore be implemented.

In a further embodiment of the invention, the polarization direction of an antenna for transmission signals differs from the polarization direction of an antenna for reception signals.

The excitation of a reception antenna by a corresponding transmission antenna fitted in the same radio station can thus be prevented.

The invention is described in detail below with reference to preferred embodiments, which are explained by means of the figures listed below.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of an antenna array with different antennas for transmission signals and reception signals;

Figure 2 is a block diagram of an antenna array with different antennas for different frequency ranges, transmission signals and reception signals;

Figure 3 is a block diagram of an antenna array with different antennas for transmission signals and reception signals, and for reception signals of different frequency ranges;

Figure 4 is a block diagram of an antenna array with different antennas for transmission signals and reception signals, and for transmission signals of different frequency ranges;

Figure 5 is a cross-sectional view of a patch antenna;

Figure 6 is an antenna array with different polarization directions for transmission signals and reception signals;

Figure 7 is a block diagram of a radio station; and

Figure 8 is a block diagram of a conventional antenna array.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the preferred embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Figure 1 shows a block diagram of an antenna array A, in which different antennas ANT are provided for the transmission mode and the reception mode. In order to show the embodiments clearly, the block

diagrams of the antenna arrays are substantially simplified and therefore show no passive components, such as filters, 50-ohm adapter circuits, or power-regulating loops of the amplifiers. The transmission and reception amplifiers can also be regarded as representing the transmission and reception paths.

In the context of this application, an "antenna" also contains a resonator and a connection assigned to this resonator.

GSM and DCS transmission signals are amplified by a GSM DCS power amplifier GSM DCS PA and are fed and emitted via a connection of the associated antenna ANT1 which is adapted to the transmission frequency band of the GSM 900 frequency range and to the transmission frequency band of the DCS 1800 frequency range.

GSM and DCS reception signals are received by a second antenna ANT2 which is adapted to the reception frequency band of the DCS 1800 frequency range and to the reception frequency band of the GSM 900 frequency range. Following corresponding filtering by a diplexer, the signals are amplified by corresponding reception amplifiers DCS LNA (low noise amplifiers) GSM LNA. It is thus possible to dispense with antenna switches and thereby implement a small, lightweight antenna array.

Figure 2 shows a block diagram of an antenna array A, in which different antennas ANT are provided for different frequency bands and different antennas are likewise provided for the transmission mode and the reception mode.

GSM transmission signals are amplified by a GSM power amplifier GSM PA and are fed via a connection of the associated antenna ANT1 which is adapted to the

transmission frequency band of the GSM 900 frequency range. DCS transmission signals are amplified by a corresponding different power amplifier DCS PA and are fed to a second antenna ANT2 which is adapted to the transmission frequency band of the DCS 1800 frequency range and is emitted there.

DCS reception signals are received by a third antenna ANT3 which is adapted to the reception frequency band of the DCS 1800 frequency range, are amplified by a corresponding reception amplifier DCS LNA (low noise amplifier) and, following demodulation and filtering, are fed to a digital signal processor of a radio station. GSM reception signals are received by a fourth correspondingly adapted antenna ANT4 and are amplified by a corresponding reception amplifier device GSM LNA. It is thus possible to dispense with antenna switches and diplexers and thereby implement a small, lightweight antenna array.

In designs of the invention, further antennas are provided which are either likewise used to implement frequency duplex operation, albeit in a different frequency range, or to implement time duplex operation in a different frequency range, to which antenna switches or diplexers can be assigned for signal separation. Examples of further frequency ranges are the frequency ranges of third-generation mobile radio systems such as the UMTS system which is currently being standardized (combination of wideband CDMA and TD/CDMA), or other CDMA systems, the DECT system, or other cordless systems.

Figure 3 shows an embodiment which differs from the design shown in Figure 1 in that different antennas ANT2, ANT3 are provided for the reception signals

according to the different frequency ranges, thereby eliminating the need for a diplexer.

Figure 4 shows an embodiment which differs from the design shown in Figure 1 in that different transmission amplifiers GSM PA, DCS PA and different antennas are provided according to the different frequency ranges.

Figure 5 shows a section view of a patch antenna comprising a connection ANK, a ground area M, an insulation, for example ceramic, a substrate SUB, a resonator RES and a short circuit K between the resonator RES and the ground area M. The polarization direction POL of a patch antenna of this type is indicated by the double arrow. The signals can also be connected in a different manner to that shown here, for example capacitively.

Figure 6 shows an antenna array comprising four antennas which correspond to a transmission mode and a reception mode in two frequency ranges and which are arranged on a support, for example a board or substrate SUB, with corresponding connections ANK1-4, resonators RES1-4, and short circuits K1-4 between the ground area and the resonators.

In order as far as possible to prevent the excitation of a reception antenna by the corresponding transmission antenna in the same frequency range, the polarization directions of the corresponding transmission and reception antennas are aligned at right angles to one another.

In a different design of the invention, the different antennas are physically separated and are implemented with the maximum possible spacing between

them. This can also result in prevention of the aforementioned undesirable excitations.

In a different embodiment, all or at least some of the antennas are aligned in parallel with one another.

In a further embodiment of the invention, the individual antennas or resonators are narrowband antennas or resonators. This can also result in prevention of the aforementioned undesirable excitations.

Figure 7 shows a radio station which may, in particular, be a mobile station MS, comprising an operating unit MMI, a control device STE, a processing device VE, a power supply device SVE, a reception device EE, and a transmission device SE.

The control device STE essentially comprises a program-controlled microcontroller, which controls and monitors all essential elements and functions of the radio station.

The processing device VE can also be formed by a digital signal processor DSP.

The radio-frequency component HF comprises the transmission device SE, with a modulator and an amplifier, and a reception device EE with a demodulator and likewise an amplifier.

The frequency of a voltage-controlled oscillator VCO is fed via the synthesizer SYN to the transmission device SE and the reception device EE. The system clock for timing the processor devices of the equipment can also be generated by means of the voltage-controlled oscillator VCO. Reception signals are received and transmission signals are transmitted via the antenna array A, as shown in Figure 1.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirt of the invention are desired to be protected